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THE FIRST SOVIET 800 RAIL-STRUCTURAL MILL

Engr I. A. Revin
Stalin Prize Winner

General Layout

The 800 rail-structural mill, which won a Stalin Prize for its designers and builders, was turned out by the Sverdlovsk Uralmash Plant imeni Ordzhonikidze in 1949. Its performance since then has surpassed that of similar mills produced in the United States.

The entire mill, consisting of 240 machines and mechanisms, is housed in a building 547.5 meters long and 141.5 meters wide. It turns out rails weighing 43-75 kilograms per running meter, and 12.5-25 meters long; I-beams ranging from No 20 to No 60; channel beams ranging from No 20 to No 40; other shaped cross-section products measuring 4-24 meters long; and billets of round and square cross section up to 6 meters long. Finished products are rolled from steel billets of 330-millimeter square cross sections, which are up to 5 meters long, and weigh as much as 4.1 tons.

[Description of the layout and operation of the 800 mill may be followed in Figure 1. The shop areas and equipment are listed as numbered in the plan.]

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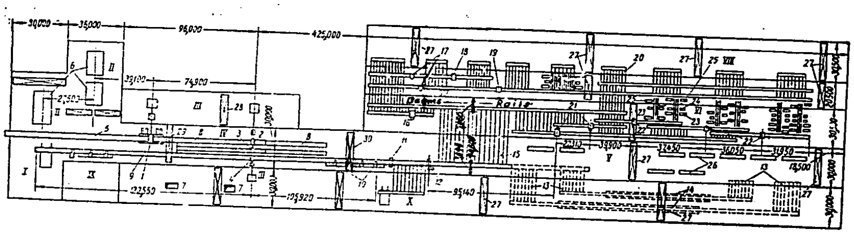

Figure 1. Layout of Equipment

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I. Billet stock

II. Furnace area

III. Machinery area

IV. Mill area

V. Heat-treatment department

VI. Rail-finishing area

VII. Beam-finishing area [A vertical arrow, indicating a distance of 7,060 millimeters, divides the beam-finishing area, on the left, from the rail-finishing area on the right.]

VIII. Finished products stock

IX. Roll-lathe department

X. Pipe-billet stock

1. Two-high reversing stand; roll diameter, 900 mm

2, 3. Three-high stands; roll diameter, 850 mm

4. Two-high stand; roll diameter, 800 mm

5. Feed roll table

6. Heating furnaces

7. Pits for receiving scale

8. Take-off roll tables and pull-overs

9. Return constant-flow line

10. [illegible]

11. Stamping machine

12. Bending machine

13. Pull-overs

14. Normalizing furnaces

15. Cooler

16. Straightening machine

17. Horizontal straightening press

18. Cold-cutting shears

19. Cold-cutting saw

20. Racks

21. Straightening machine

22. Vertical straightening presses

23. Milling machine

24. Drilling machine

25. Hardening unit

26. Cooling boxes

27. Crane, 15-ton capacity

28. Crane, 30- and 5-ton capacity

29. Crane, 7[illegible]- and [illegible]5-ton capacity

30. Crane, [illegible]0- and 20-ton capacity

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Billets coming from an 1150 blooming mill at a temperature of 700-800 degrees are moved by roll tables, a car, and a crane to compartment furnaces, where their temperature is brought up to 1,150-1,250 degrees. A second crane and a car transfer the billets to the feed roll table of a 900 roughing train.

To permit operation of the 800 mill independently of the 1150 blooming mill, there is a continuous furnace for heating cold billets. It is equipped with feeders, roll tables, and pull-overs. Billets heated in this furnace also move onto the feed roll table of the 900 roughing train.

Roughing and Planishing Trains

The 900 roughing train consists of a single two-high reversing stand with rollers 900 millimeters in diameter by 2,300 millimeters. The mill is equipped with roll tables and manipulators with a turnover device. It is powered by a 5,000-horsepower electric motor set to make 120-500 revolutions per minute, acting through gear and arbor transmission. The blooms generally undergo five passes in the 900 train, coming out in rough cross-section lengths of 9-12 meters. Thence they pass on to the 800 planishing train.

The 800 planishing train comprises a pair of three-high stands [set side-by-side] equipped at both faces with tilting tables having "disappearing" manipulators and turnover devices. Each stand, as shown in Figure 2, consists of two housings 1 and 2, a top member 3, a set of bearings 4, having textolite linings 5, a set of rollers 6, and a pressure mechanism 7, for the upper and lower rollers. The axial position of the rollers is maintained by clamps 8, 9, and 10, secured to the housing by bolts 11. The top member is attached to the housing by the wedge fastenings 12. To eliminate play between the upper lining and the neck of the middle roller, there is another wedge fastening 13.

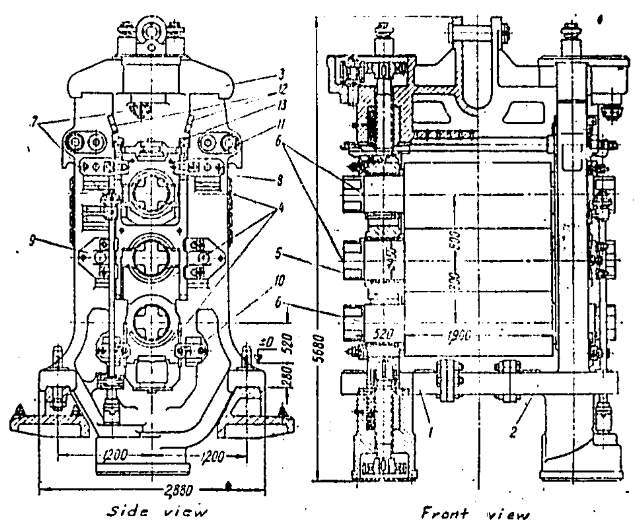

Figure 2. Planishing Train Stand

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Both stands are powered by a 6,200-horsepower electric motor, making 0-80-160 revolutions per minute. These stands roll the bars into shaped cross sections of the desired dimensions in six to eight passes.

The bars are shifted from one groove to the next by the disappearing manipulators and turnover devices, which drop down below the level of the rollers after the bar has been set in the groove, and move over to the next groove, ready to put the following bar into it. The bars are moved from one stand to the other on roll tables and pull-overs.

From the planishing train, the hot bars proceed to the 300 finishing train, which consists of a single two-high reversing stand. A roll table with disappearing manipulator and turnover device is situated at the front of the stand; a discharge roll table faces the rear. The stand is powered by a 2,500-horsepower electric motor, making 0-80-160 revolutions per minute.

From the finishing stand the bars, brought to their final cross-section dimensions in 60-meter lengths, are fed by roll tables to four carriage-mounted moving saws, where they are cut into lengths ranging from 4 to 25 meters. At the same time the ends and the test samples are cut off.

The disk saws are run by electric motors; their feed speed is regulated automatically. The saws are equipped with roll tables, transferable clamps, an adapter, and mechanisms for removing the bar ends and cutting the laboratory samples. The /receiving/ boxes of the mechanism for removing the ends are mounted on carriages and moved by electric drive to the saws.

Round bars are held by three movable clamps while being cut.

Finishing of Rails

After they have been cut, the rail sections pass through a stamping machine, which automatically marks on them the heat number and the numbers /in order/ of the rails rolled from a single ingot. The rails then proceed to the bending machine, where they are bent base-outward, i. e., in a direction opposite to that of the natural bend. Next, the rails go to a discharge roller table.

A cable pull-over moves the rails from the roll table to a cooler, where their temperature is brought down to 20-50 degrees.

An electric-powered mechanism, shown in Figure 3, moves the trolleys of the pull-over. Transverse iron beams 1, are secured to shoes 2, of a rail floor 3. The pull-over trolleys move along the track 4. The mechanism 5, which turns the catches of the pull-over trolleys as they move ahead, consists of I-beams 6, levers 7, transmission 8, reduction mechanism 9, connecting rod 10, and counterweight 11.

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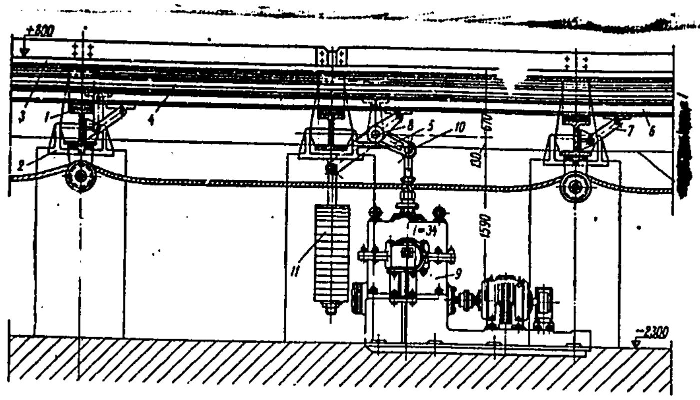

Figure 3. Mechanism for Moving the Pull-Over Trolleys

The cooled rails, in groups of three or four, are moved by cable pull-overs onto the discharge roll table of the cooler, thence via feed roll tables and pull-overs of the racks to the roll straighteners.

The rails are laid out on the rack until it is fully loaded with them; then the same pull-overs dump them one by one onto the straightening machine's feed roll table.

The rails are straightened in one pass through the roll straightener. Emerging from it, they are turned from their bases onto their sides by an automatic turnover machine which is built into the discharge roll table.

Pull-overs and roll tables then move the rails to the vertical straightening presses.

The rails are put on racks; then, when these are full, go onto feed roll tables which take them to presses for final straightening. Hoists attached to these roll tables check the advance of the rails, and hold them under the presses in position for straightening.

Reversing turnover devices at the presses set the rails on their bases after final straightening has been effected. These turnover devices can turn the rails through 360 degrees, stopping them automatically at [each] 90-degree point.

The rails go next to the automatic constant-flow lines for finishing operations. Cable pull-overs having feed carriages then move them to the buffer part of the rack, which is just in front of the milling machines, and lay them out at 300-millimeter intervals.

Centering devices automatically set the rails at the distances from the milling machine which correspond to the amount of metal to be removed from the left end, and at the same time hold in position those rails whose length exceeds the permissible length for milling. This prevents the milling cutter from breaking.

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The pawl pull-overs of the first, second, and third constant-flow rail lines periodically move the rails from the buffer section of the racks and along [another] rack through 500-millimeter intervals, so that they proceed in turn to the milling and drilling machines and to the hardening units. The layout of the pawl pull-over of the constant-flow lines is shown in Figure 4.

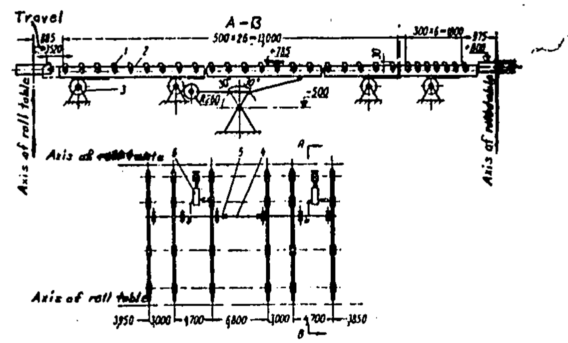

Figure 4. Pawl Pull-Over

The pawl pull-overs consist of drop-forged steel catches 1, welded frames 2, supporting rollers 3, transmission shaft 4, clutch 5, and crank drive 6.

When the pawl pull-over stops, the rails appear in front of the machine tools and tempering units, which at this juncture are automatically turned on. The automatic clamps of the milling machines seize the rails, and the rail ends are milled the prescribed amount; after this, the machines resume their initial positions, and the pawl pull-over automatically moves one step forward.

The hoists, equipped with feeders, and the drilling machines are also fully automatic: after the rail has been lifted over the rack, it is passed on to the drilling machine and secured to it, after which holes are drilled in it. After the holes have been drilled, the pawl pull-over moves [another] step ahead. The tempering unit automatically lowers an inductor over the head of the rail end, and heats it to a temperature of 800-850 degrees; simultaneously, the water is turned on for quenching the rails which were heated during the preceding cycle.

When the water is turned off, and the inductor returns to its initial position, the pawl pull-over again advances one step.

The duration of the automatic constant-flow line cycle is determined by the tempering operation, which requires a rapid transfer of the heated rail under the cooling sprayer, and takes 50-100 seconds.

The pawl pull-over, then, moving one step ahead (500 millimeters) moves all the rails remaining on the rack a distance of 500 millimeters, taking the finished rails away from the machine tools, and feeding new ones up to them.

The action of the pawl pull-over is illustrated in Figure 5.

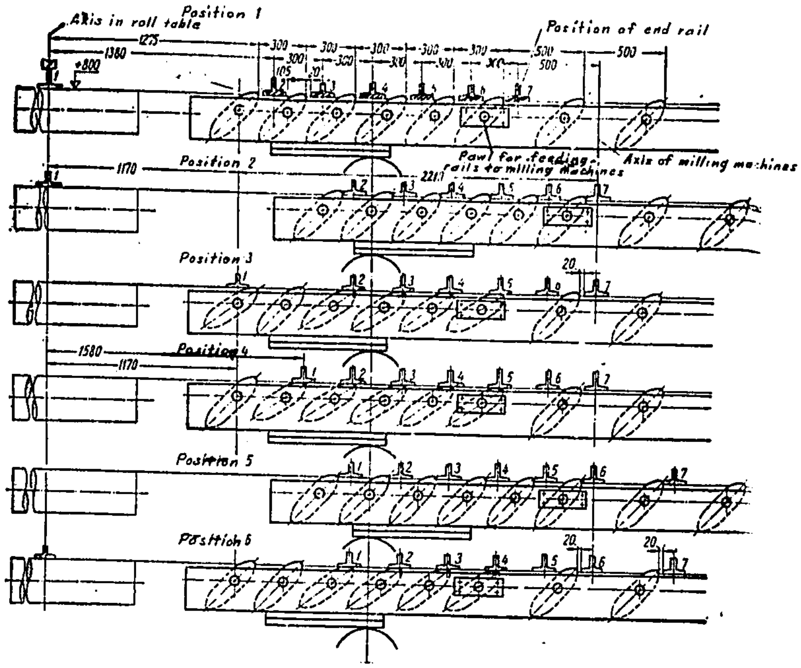

Figure 5. Action of Pawl Trolleys

After the heads of the rail ends have been hardened, the pawl pull-overs move the rails to the feed roll tables leading to the inspection tables. The rails are moved automatically from the roll table to the rack in front of the turnover devices and are laid out base down at 250-millimeter intervals. After six rails have been laid out, the pawl pull-over moves them in a batch to turnover devices which turn them through 270 degrees, stopping them at every 90 degrees for inspection.

Defective rails are fed onto the rejects roller table and laid out on the rack in front of the finishing line; the sound rails go onto the rack for painting and marking. The completed rails are run into tilting containers, in which they are canted onto their bases and gathered up in groups of 10-12; a magnetic crane then moves them to the finished products stock.

The rails are tested in the impact-testing department, equipped with a pendulum impact-testing machine and rail breaker. The sawn-off impact-test samples run into containers from which a crane moves them onto a rack for cooling. When cooled, the test samples are pushed off the rack onto an inclined chain conveyer and then, via a roll table, to the pendulum impact-testing machine.

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The samples for the rail breaker move down an inclined plate to the roll table in front of a stationary saw, and along an inclined trough, roll table, and conveyer. As the samples move along the conveyer, they are cooled by water sprays located above the conveyer. From the conveyer the samples go to another roll table, which carries them to the rail breaker. The used rail samples are carried away on cars.

Finishing of Shaped Cross-Section Lengths

Girders, beams, and other rolled products of shaped cross section are cut by saws into required lengths, marked, and then, by-passing the bending machine, move by roll table to a cooler. The cooled beams and girders move singly or in batches of up to four to a rack for the roll-straightening machine. Straightening is effected in one pass through the machine, after which the bars proceed by roll tables and pull-overs to the horizontal straightening presses. Friction-action hoists, built into the roll-table presses, arrest the bars and set them up in the straightening position.

After final straightening, the bars are inspected, and then pass to the finished products stock.

Bars under 12 meters long go to a shear for cold cutting of shaped cross-section metal, where they are cut into lengths of 4-8 meters. The short bars also undergo inspection and selection and then are sent to the finished products stock.

Cold-cutting saws are set up at the end of the beam-finishing line; they cut off the faulty sections of rolled stock. From here the beams undergo inspection and then move to the finished products stock.

Finishing of Round and Square Billets of Alloyed and Carbon Steel

Rolled billets pass from the rolling stands along roll tables to the moving carriage saws, which cut them up into lengths of 4-12 meters. Then the billets of alloyed steel go onto racks, while those of carbon steel move to a cooler. The cooled billets are transported to the beam-finishing department and to the finished products stock.

For use in the production of blooms of alloyed and carbon steel, on orders from other enterprises, there is a return constant-flow line equipped with roll tables, saws, shears for hot cutting, and feeders. Completed blooms are moved by crane to the finished products stock.

Remarks

In regard to the design of the machinery and mechanisms of the 800 rolling mill, it should be noted that the rigidity of both the two-high and three-high mills has been increased by the use of the wedge fastenings to secure the top member to the housing, and the use of the rigid bearings of the middle roller. These features have raised the rigidity of the open stand to that of the closed, and permit reduction of the flange thickness of structural members more than 30 percent without lowering their sturdiness.

The tilting tables before and behind the stands are of considerable interest. The disappearing manipulators and turnover devices with hydraulic drive are lowered beneath the roll table, so that during the passage of the first bar the manipulator and turnover device may be set to a different calibre for handling the second bar. Thus, two bars can be rolled simultaneously in each of the three-high stands.

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The design of the stand provides for broad unification of hoist and transport installations. Nearly all the rolls for the roll tables are made of pipe with swaged (obzhatyy) journals. On the group-drive roll tables, the roller barrels measure 350 and 450 millimeters in diameter, and are 1,100 and 2,200 millimeters long. The roll tables with individual drive have roller barrels 250 millimeters in diameter and 1,100 millimeters long. All group-drive roll tables (except those for the hot-cutting shears) are made up of a drive section consisting of four rollers, and several nondrive sections of four rollers each.

Rolls are driven by ADOF-42/6 2-kilowatt high-speed electric motors making 1,000 revolutions per minute, and equipped with two-stage reduction units. These motors are used instead of the slow-speed AERF-44/16 16-kilowatt motor making 375 revolutions per minute and provided with single-stage reduction units and elastic clutches, because, with the former motors, more simply constructed drive rolls can be used. A saving of 100 man-hours was realized in the manufacture of each of these rolls, while 1,468 rubles were saved in the cost of each electric motor; for the entire mill, a saving of 72,000 man-hours was realized in the manufacture of the mechanical part of the rolls, and a total of 1,056,960 rubles were saved on the cost of the electric motors.

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